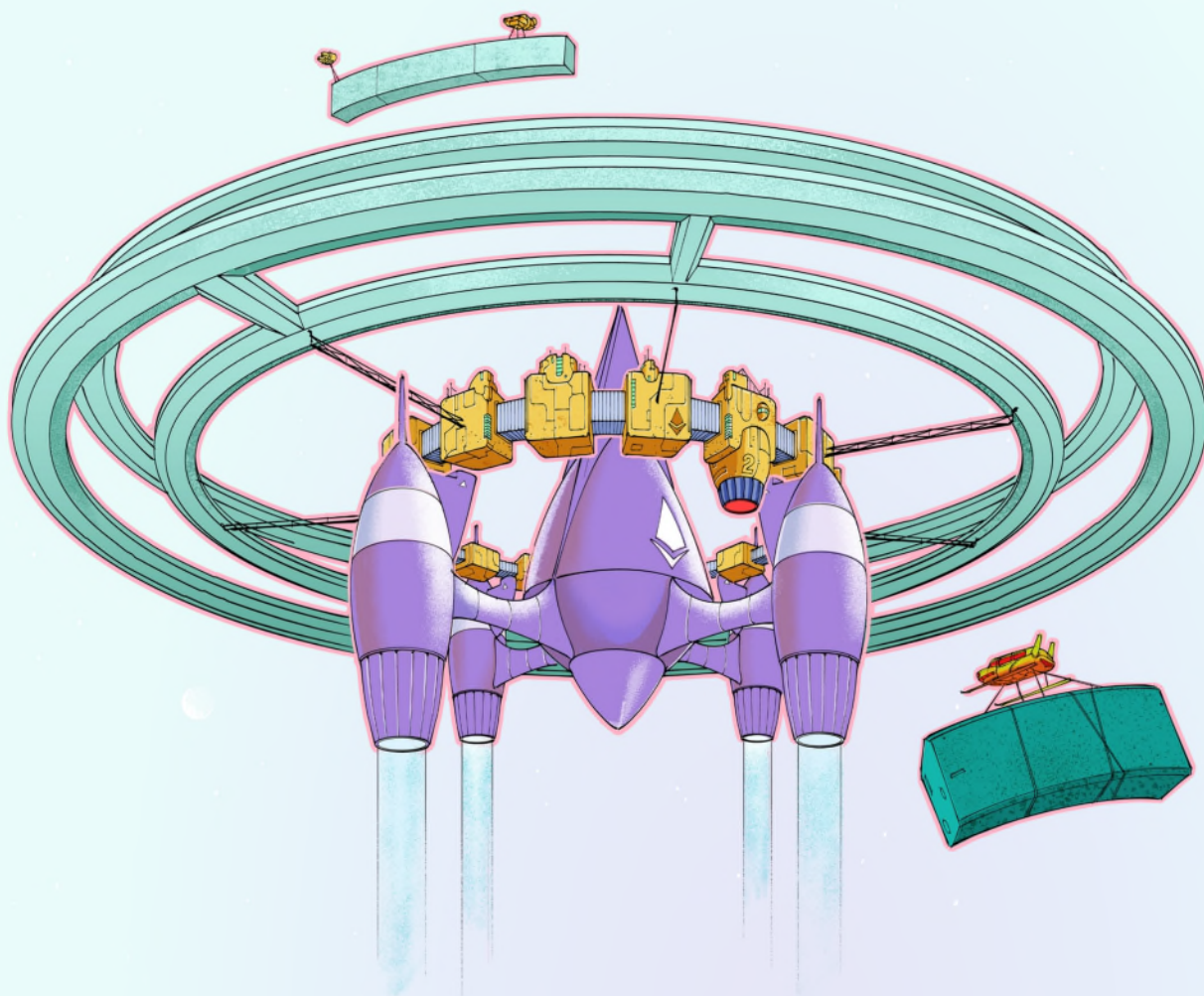


# Exhibit 291



UPGRADES / [MERGE](#)

# The Merge

- Ethereum Mainnet uses proof-of-stake, but this wasn't always the case.
- The upgrade from the original proof-of-work mechanism to proof-of-stake was called The Merge.
- The Merge refers to the original Ethereum Mainnet merging with a separate proof-of-stake blockchain called the Beacon Chain, now existing as one chain.
- The Merge reduced Ethereum's energy consumption by ~99.95%.

Page last updated: November 21, 2022

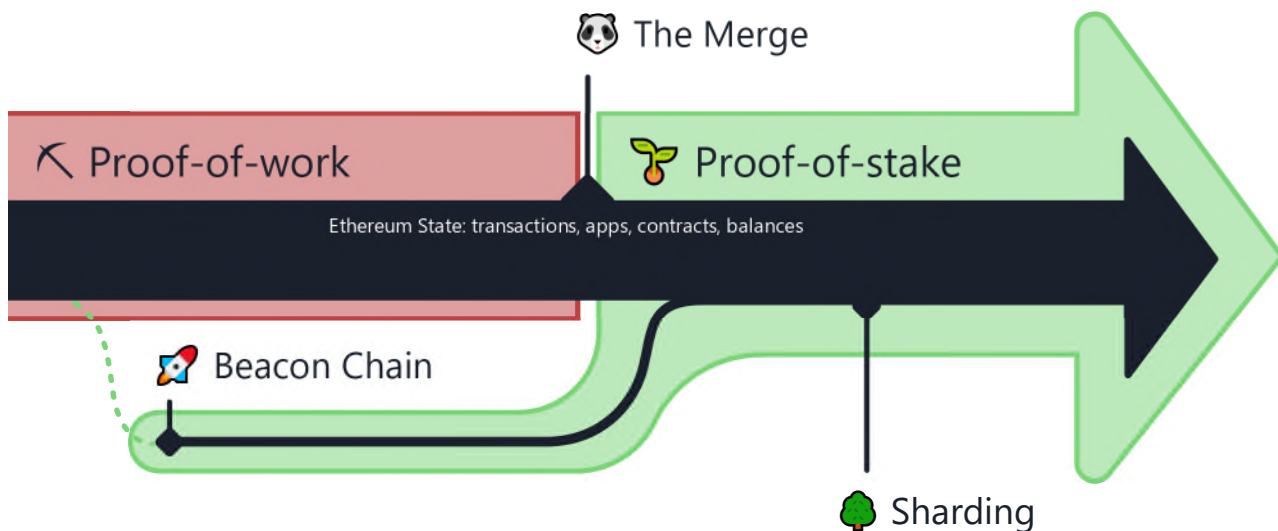
WHEN'S IT SHIPPING?

## Shipped!

The Merge was executed on September 15, 2022. This completed Ethereum's transition to proof-of-stake consensus, officially deprecating proof-of-work and reducing energy consumption by ~99.95%.

## What was The Merge?

The Merge was the joining of the original execution layer of Ethereum (the Mainnet that has existed since [genesis](#)) with its new proof-of-stake consensus layer, the Beacon Chain. It eliminated the need for energy-intensive mining and instead enabled the network to be secured using staked ETH. It was a truly exciting step in realizing the Ethereum vision—more scalability, security, and sustainability.



Initially, the [Beacon Chain](#) shipped separately from [Mainnet](#) <sup>?</sup>. Ethereum Mainnet - with all its accounts, balances, smart contracts, and blockchain state - continued to be secured by [proof-of-work](#), even while the Beacon Chain ran in parallel using [proof-of-stake](#). The Merge was when these two systems finally came together, and proof-of-work was permanently replaced by proof-of-stake.

Imagine Ethereum is a spaceship that launched before it was quite ready for an interstellar voyage. With the Beacon Chain, the community built a new engine and a hardened hull. After significant testing, it became time to hot-swap the new engine for the old one mid-flight. This merged the new, more efficient engine into the existing ship enabling it to put in some serious lightyears and take on the universe.

## Merging with Mainnet

Proof-of-work secured Ethereum Mainnet from genesis until The Merge. This allowed the Ethereum blockchain we're all used to to come into existence in July 2015 with all its familiar features—transactions, smart contracts, accounts, etc.

Throughout Ethereum's history, developers prepared for an eventual transition away from proof-of-work to proof-of-stake. On December 1, 2020, the Beacon Chain was created as a separate blockchain to Mainnet, running in parallel.

The Beacon Chain was not originally processing Mainnet transactions. Instead, it was reaching consensus on its own state by agreeing on active validators and their account balances. After extensive testing, it became time for the Beacon Chain to reach consensus on real world data. After The Merge, the Beacon Chain became the consensus engine for all network data, including execution layer transactions and account balances.

The Merge represented the official switch to using the Beacon Chain as the engine of block production. Mining is no longer the means of producing valid blocks. Instead, the proof-of-stake validators have adopted this role and are now responsible for processing the validity of all transactions and proposing blocks.

No history was lost in The Merge. As Mainnet merged with the Beacon Chain, it also merged the entire transactional history of Ethereum.

This transition to proof-of-stake changed the way ether is issued. Learn more about [ether issuance before and after The Merge](#).

## Users and holders

**The Merge did not change anything for holders/users.**

*This bears repeating:* As a user or holder of ETH or any other digital asset on Ethereum, as well as non-node-operating stakers, **you do not need to do anything with your funds or wallet to account for The Merge.** ETH is just ETH. There is no such thing as "old ETH"/"new ETH" or "ETH1"/"ETH2" and wallets work exactly the same after The Merge as they did before—people telling you otherwise are likely scammers.

Despite swapping out proof-of-work, the entire history of Ethereum since genesis remained intact and unaltered by the transition to proof-of-stake. Any funds held in your wallet before The Merge are still accessible after The Merge. **No action is required to upgrade on your part.**

[More on Ethereum security](#)

## Node operators and dapp developers

### Staking node operators and providers

[More](#)

If you are a staker running your own node setup or a node infrastructure provider, there are a few things you need to be aware of after The Merge.

## Non-validating node operators and infrastructure providers

If you're operating a non-validating Ethereum node, the most significant change that came with The Merge was the requirement to run clients for BOTH the execution layer AND the consensus layer.

[More](#)

## Dapp and smart contract developers

The Merge was designed to have minimal impact on smart contract and dapp developers.

[More](#)

# The Merge and energy consumption

The Merge marked the end of proof-of-work for Ethereum and start the era of a more sustainable, eco-friendly Ethereum. Ethereum's energy consumption dropped by an estimated 99.95%, making Ethereum a green blockchain. Learn more about [Ethereum energy consumption](#).

# The Merge and scaling

The Merge also set the stage for further scalability upgrades not possible under proof-of-work, bringing Ethereum one step closer to achieving the full scale, security and sustainability outlined in its [Ethereum vision](#).

# Misconceptions about The Merge

**Misconception: "Running a node requires staking 32 ETH."**[More](#)

False. Anyone is free to sync their own self-verified copy of Ethereum (i.e. run a node).

No ETH is required—not before The Merge, not after The Merge, not ever.

**Misconception: "The Merge failed to reduced gas fees."**[More](#)

False. The Merge was a change of consensus mechanism, not an expansion of network capacity, and was never intended to lower gas fees.

**Misconception: "Transactions were accelerated substantially by The Merge."**[More](#)

False. Though some slight changes exist, transaction speed is mostly the same on layer 1 now as it was before The Merge.

**Misconception: "The Merge enabled staking withdrawals."**[More](#)

False. Staking withdrawals are not yet enabled with The Merge. The following Shanghai upgrade will enable staking withdrawals.

**Misconception: "Validators will not receive any liquid ETH rewards til the Shanghai upgrade when withdrawals are enabled."**[More](#)

False. Fee tips/MEV are credited to a non-staking account controlled by the validator,

available immediately.

**Misconception: "When withdrawals are enabled, stakers will all exit at once."**

[More](#)

False. Validator exits are rate limited for security reasons.

## What happened to 'Eth2'?

The term 'Eth2' has been deprecated. After merging 'Eth1' and 'Eth2' into a single chain, there is no longer any need to distinguish between two Ethereum networks; there is just Ethereum.

To limit confusion, the community has updated these terms:

- 'Eth1' is now the 'execution layer', which handles transactions and execution.
- 'Eth2' is now the 'consensus layer', which handles proof-of-stake consensus.

These terminology updates only change naming conventions; this does not alter Ethereum's goals or roadmap.

[Learn more about the 'Eth2' renaming ↗](#)

## Relationship between upgrades

The Ethereum upgrades are all somewhat interrelated. So let's recap how The Merge relates to the other upgrades.

### The Merge and the Beacon Chain



The Merge represents the formal adoption of the Beacon Chain as the new consensus layer to the original Mainnet execution layer. Since The Merge, validators are assigned to secure Ethereum Mainnet, and mining on [proof-of-work](#) is no longer a valid means of block production.

Blocks are instead proposed by validating nodes that have staked ETH in return for the right to participate in consensus. These upgrades set the stage for future scalability upgrades, including sharding.

The Beacon Chain

## The Merge and the Shanghai upgrade

In order to simplify and maximize focus on a successful transition to proof-of-stake, The Merge upgrade did not include certain anticipated features such as the ability to withdraw staked ETH. The Shanghai upgrade is planned to follow The Merge, which will enable the ability for stakers to withdraw.

Stay up-to-date with the [Shanghai upgrade planning issue on GitHub ↗](#) , or the [EF Research and Development Blog ↗](#) . For those curious, learn more about [What Happens After The Merge ↗](#) , presented by Vitalik at the April 2021 ETHGlobal event.

## The Merge and sharding

Originally, the plan was to work on sharding before The Merge to address scalability. However, with the boom of [layer 2 scaling solutions](#), the priority shifted to swapping proof-of-work to proof-of-stake first.

Plans for sharding are rapidly evolving, but given the rise and success of layer 2 technologies to scale transaction execution, sharding plans have shifted to finding the most optimal way to distribute the burden of storing compressed calldata from rollup contracts, allowing for exponential growth in network capacity. This would not be possible without first transitioning to proof-of-stake.

[Sharding](#)

## Further reading

<a href="#">Ethmerge</a> Ethmerge	<a href="#">↗</a>
<a href="#">The Merge is Coming</a> Alchemy	<a href="#">↗</a>
<a href="#">The State of The Merge: An Update on Ethereum's Merge to Proof of Stake in 2022</a> Consensys	<a href="#">↗</a>
<a href="#">Announcing the Ropsten Merge Testnet</a> Ethereum Foundation	<a href="#">↗</a>
<a href="#">Execution layer specs</a> Ethereum Foundation	<a href="#">↗</a>
<a href="#">Consensus layer specs</a> Ethereum Foundation	<a href="#">↗</a>
<a href="#">Engine API specs</a> Ethereum Foundation	<a href="#">↗</a>
<a href="#">The Hitchhikers Guide To Ethereum</a> Delphi Digital	<a href="#">↗</a>

# Test your knowledge



## The Merge

**The Merge moved Ethereum onto which consensus mechanism?**

- ☐ A Proof-of-work
- ☐ B Proof-of-stake
- ☐ C Proof-of-authority
- ☐ D All of the above

Submit answer

**Was this page helpful?**



Yes



No

≡ [Guide to Ethereum upgrades](#)

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## Use Ethereum

[Find wallet](#)

[Get ETH](#)

[Decentralized applications \(dapps\)](#)

[Layer 2](#)

[Run a node](#)

[Stablecoins](#)

[Stake ETH](#)

## Learn

[What is Ethereum?](#)

[What is ether \(ETH\)?](#)

[Ethereum wallets](#)

[Community guides and resources](#)

[History of Ethereum](#)

[Ethereum Whitepaper](#)

[Ethereum upgrades](#)

[Ethereum security and scam prevention](#)

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